UNIVERSITY OF SOUTHERN QUEENSLAND

DOPPLER IMAGING OF YOUNG SOLAR-TYPE STARS USING THE ANU 2.3 M SIDING SPRING TELESCOPE.

A dissertation submitted by
Donna Marie Burton
B.Sc. (Computing)

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School of Agricultural, Computational, Environmental Sciences
University of Southern Queensland

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Abstract

The study of surface activity on young solar-type stars provides an opportunity to improve understanding of stellar dynamos and indirectly gain insight into early solar evolution. Doppler Imaging (DI) can be used to map stellar surface activity, and utilises rotation-induced Doppler-broadening of spectral lines to calculate the surface distribution of a fundamental parameter such as temperature.

DI requires high-resolution spectroscopic observations distributed over one or more stellar rotation periods. To date only a limited number of single young solar analogues have been observed using this technique. Observations of many stars at various evolutionary states and with varying physical parameters are necessary to comprehensively constrain stellar dynamo models. These observations require long-term access to a telescope with a high-resolution echelle spectrograph to undertake multiple epoch studies of stellar activity.

This project has used the ANU 2.3 metre telescope to test Doppler Imaging with two active young stars, AB Doradus (AB Dor) and HIP43720, with the HIP43720 observations contemporaneous with the Anglo-Australian Telescope (AAT) observations.

Analysis of the AB Dor mapping and comparison of the 2.3 metre and AAT results for HIP43720 indicates that the ANU 2.3 metre telescope with its high resolution echelle spectrograph is capable of undertaking scientifically useful Doppler Imaging for stellar dynamo surveys.

Certification of Dissertation

I certify that this dissertation contains no material accepted for the award of any other degree or diploma in any university. To the best of my knowledge, it contains no material published or written by another person, except where due reference is made in the text.

Signature of Candidate	Date

ENDORSEMENT

Signature of Supervisor	Date

Dedication

Dedicated to Stan Ramage, the best father-in-law any girl could have. I am sorry that you never got to read it, but it is finally done. Thanks for believing in me!

Dedicated also to my parents, who passed away during this last 12 months, because of whom, I have always dared to reach for the stars and to believe all things are possible, as long as you work hard at it. Especially thanks to my Dad - who taught me to hate fences and that even a 'drover's brat' can be whatever they want to be! It just took me longer than most!

Acknowledgments

This has been no easy task, interesting, challenging and certainly a revealing journey into self-discovery. I have learnt that a document that compiles perfectly, somehow fails dismally just before it is due to journey through the ether to one's supervisor. I have learnt what procrastination is. For one, who hates ironing with a passion, it was enlightening to be reminded how many times I chose to iron instead of sit down and write this document. The observing tasks, in spite of the vagaries of weather, telescope and instrument gremlins were the fun bit; as was the initial data reduction and the sense of discovery. But there were those frustrating times, when nothing would work and a sneaky bracket in LaTex would take 5 hours to find; when drafts came back with seemingly more comments than the original word count. Do I regret it all? No way! Would I do it again? Too right! But, one would hope, wiser and much better organised and realising that all those early comments and warnings from my supervisors were true and the voice of experience not just nagging!

So, these have been an interesting few years. Life has a habit getting in the way of even our best intentions. Being privileged to have looked after my Father in Law prior to his passing and then losing both my parents within a year. The stress of many long interstate trips in their final months and weeks, giving up was a tempting alternative with a full time job, house, farm and a variety of animals to care for. But, being a 'drover's brat' as my Dad so liked to remind me – giving up is not in my make up! Even when the bush fires earlier this year burnt large parts of our property and provided even more excuses to avoid the writing tasks – the support and friendship of my partner Christopher, the community of Coonabarabran, the USQ team and my friends at Siding Spring I could not have got to this point. My PhD journey surely will have to be far less rocky!

I can't find the right superlative to express my thanks and appreciation to Dr Brad Carter and his wife Lynette, for their on-going support, friendship

and assistance during the last couple of years. Without their help and that of Dr Stephen Marsden and Ian Waite who have always made me feel a part of the team I would not have had the motivation to keep on keeping on.

Help was only an email, Skype or voice call away and when things seemed insurmountable, they helped put things into perspective. Stephen and Ian have been awesome in helping me get to terms with the idiosyncrasies of the data reduction software and in navigating the unique issues involved in getting it to work with 2.3metre data. Thanks have to go to Dr Gayandhi De Silva her help with telescope time proposals and helping me come to grips with reducing echelle spectra in IRAF. Dr Carolyn Brown - thanks for being the buffer this last exhausting week.

Thanks also to Dr Jean-François Donati for allowing our team access to his ESpRIT code and the permission to use his results from the AAT and to produce the 2002 map of AB Dor.

Thanks also to staff of the USQ Office of Research and Higher Degrees Staff and in particular especially Mrs Annmaree Jackson and Sophie Ivory for their assistance at being on the end of a phone and email to help me navigate the system.

There are several free online services, including: the SIMBAD database and the Vizier Service for Astronomical Catalogues, both operated at CDS, Strasbourg, France; NASA Astrophysics Data System (ADS) Data Services, operated by the Smithsonian Astrophysical Observatory (SAO); IRAF, distributed by the National Optical Astronomy Observatory and the Hipparcos and other astronomical catalogues that were essential tools used in my research.

Finally, a huge thank-you to my long suffering partner Chris, who has been so incredibly supportive of me throughout this adventure and who now knows far more about 'spotty' stars than he probably ever wanted to. Even though your patience has been so often sorely tested you have been my rock and when I wanted to give up, you were there to push and encourage me. Also, thanks to Judy, Sue and the rest of the ladies at the old Siding Spring Lodge and Exploratory for the coffee, chocolate and a place to hide out! Unfortunately, the Lodge was destroyed in the January 2013 fires but the memories live on! That's all Folks!

Weather is God's handicap for the world's greatest astronomers. Olin J Eggen

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